1

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 03-050960
(43)Date of publication of application : 05.03.1991

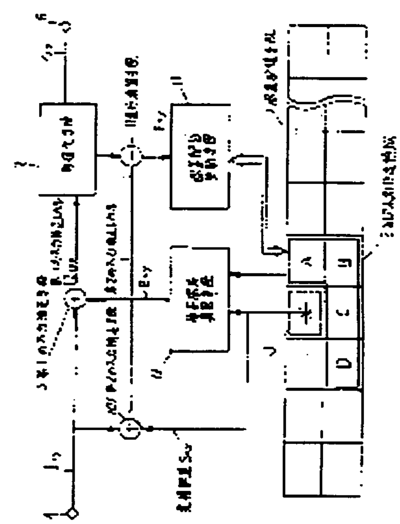
(51)Int.Cl. H04N 1/40
G06F 15/68

(21)Application number : 01-186429
(22)Date of filing : 19.07.1989

(71)Applicant : MATSUSHITA ELECTRIC IND CO LTD
(72)Inventor : KUROSAWA TOSHIHARU
KANAMORI KATSUHIRO
KAWAKAMI HIDEHIKO
KODERA HIROAKI

(54) PICTURE SIGNAL PROCESSING UNIT

(57)Abstract:



PURPOSE: To attain high speed arithmetic processing and to improve a texture of a highlight and dark area so as to obtain high definition reproduced picture by provid ing an input correction means, a multi-value processing means, a differential arithmetic means and an error distribution revision means or the like.

CONSTITUTION: An input level Ixy inputted from an input terminal 4 and a correction error level exy are corrected by a correction means 5 and the result is outputted to a multi-value processing means 7. The means 7 compares the inputted correction level with plural threshold levels, applies multi-value processing to the result to a difference arithmetic means 8. The means 8 outputs a multi-value processing error being a difference between an inputted multi-value processing level and a 2nd input correction level to an error distribution revision means 11. Then the means 11 combines plural dither matrix threshold level with other dither threshold level taking a threshold level of the multi-value processing error diffusion method as the center and rearranges the result to improve the texture in the highlight and dark region. Moreover, the picture quality is controlled by the selection of a coefficient of a correction error level exy and to attain high speed calculation by bringing the coefficient to 1/2 or 1-1/2n.

LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

整理番号　ＰＡ０４Ｃ２４３

発送番号　３８４９９４　1/
発送日　平成１５年１１月　４日

拒絶理由通知書

特許出願の番号	平成１０年　特許願　第１９６７９３号
起案日	平成１５年１０月２８日
特許庁審査官	藤本　義仁　　9012 2P00
特許出願人代理人	下出　隆史（外　２名）　様
適用条文	第２９条第２項、第３６条

この出願は、次の理由によって拒絶をすべきものである。これについて意見があれば、この通知書の発送の日から６０日以内に意見書を提出して下さい。

理　由

【理由１】
この出願の下記の請求項に係る発明は、その出願前日本国内又は外国において頒布された下記の刊行物に記載された発明に基いて、その出願前にその発明の属する技術の分野における通常の知識を有する者が容易に発明をすることができたものであるから、特許法第２９条第２項の規定により特許を受けることができない。

記　（引用文献等については引用文献等一覧参照）
・請求項　１、８、１１－１４
・引用文献等　１
・備考
引用文献１には誤差拡散法を用いた階調表現方法が記載されている。

* translated

【理由２】
この出願は、発明の詳細な説明の記載が下記の点で、特許法第３６条第４項に規定する要件を満たしていない。

記

【００６７】以降における閾値の設定につき、試行錯誤の結果が記載されているだけで、当業者が再現可能な程度に記載されているものではない。

よって、この出願の発明の詳細な説明は、当業者が請求項１、８、１１、１２、１３、１４に係る発明を実施することができる程度に明確かつ十分に記載されていない。

整理番号　ＰＡ０４Ｃ２４３　　　　　　　　　　　　発送番号　３８４９９４　　２/
　　　　　　　　　　　　　　　　　　　　　　　　　発送日　平成１５年１１月　４日

【理由３】

この出願は、特許請求の範囲の記載が下記の点で、特許法第３６条第６項第２号に規定する要件を満たしていない。

記

・請求項２、３、６、８に記載の「発生比率」とは何を指すのが不明である。

・請求項２の「滑らかに」という記載ではその技術的な意味が不明である。

・請求項３、６は請求項１を引用しているにも拘わらず、「前記発生比率」と有るのは請求項の引用関係からして不明である。

・請求項６の「有意な値」という記載ではその技術的な意味が不明である。

・請求項７、８の「急激に変化する階調値」という記載ではその技術的意味が不明である。

・請求項７の「異なる階調値」という記載ではその技術的意味が不明である。

よって、請求項２、３、６、８　　　に係る発明は明確でない。

この拒絶理由通知書中で指摘した請求項以外の請求項に係る発明については、現時点では、拒絶の理由を発見しない。拒絶の理由が新たに発見された場合には拒絶の理由が通知される。

引　用　文　献　等　一　覧

1.特開平０３－０５０９６０号公報

先行技術文献調査結果の記録

・調査した分野　　ＩＰＣ第７版　Ｂ４１Ｊ　２／２１，２／２０５
　　　　　　　　　　　　　　　　Ｈ０４Ｎ　１／２３

・先行技術文献　　国際公開第９８／００３３４１号パンフレット
　　　　　　　　　特開平１０－０８１０２６号公報
　　　　　　　　　特開平０９－１８３２４０号公報
　　　　　　　　　特開平０６－３３６０３５号公報
　　　　　　　　　特開平０９－０９８２９０号公報
　　　　　　　　　特開平０５－１９１６３９号公報
　　　　　　　　　特開２０００－０５００７０号公報
　　　　　　　　　特開２０００－００６４４５号公報
　　　　　　　　　特開平１１－２０７９４７号公報
　　　　　　　　　特開平１１－３４８３２２号公報
　　　　　　　　　特開平１１－２７７７３０号公報

この先行技術文献調査結果の記録は、拒絶理由を構成するものではない。

09/339,959

PTO 04-1759

Japanese Kokai Patent Application
No. Hei 3[1991]-50960

IMAGE SIGNAL PROCESSOR

Yoshiharu Kurosawa, et al.

UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. FEBRUARY 2004
TRANSLATED BY THE RALPH MCELROY TRANSLATION COMPANY

JAPANESE PATENT OFFICE
PATENT JOURNAL (A)
KOKAI PATENT APPLICATION NO. HEI 3[1991]-50960

Int. Cl.^{5}:	H 04 N 1/40 G 06 F 15/68 H 04 N 1/40
Sequence Nos. for Office Use:	9068-5C 8419-5B
Filing No.:	Hei 1[1989]-186429
Filing Date:	July 19, 1989
Publication Date:	March 5, 1991
No. of Claims:	3 (Total of 8 pages)
Examination Request:	Not filed

IMAGE SIGNAL PROCESSOR

[Gazo shingo shori sochi]

Inventors:	Yoshiharu Kurosawa, et al.
Applicant:	Matsushita Electric Industry Co., Ltd.

[Attached amendments have been incorporated into the text of the translation.]

Claims /1*

1. An image signal processor used for a multi-value conversion of the levels of a multi-tone image signal sampled by the unit of a pixel, which processor is equipped with an error storage means which stores a multi-value conversion error of a target pixel in correspondence with the positions of the pixels around it, a correcting error computation means which adds the accumulated error corresponding to the position of the target pixel in the aforementioned error storage means to surrounding errors in order to output an error correction level, a first input

* [Numbers in the right margin indicat pagination of the foreign text.]

correction means which adds the aforementioned error correction level with the input level of the aforementioned target pixel in order to output a first input correction level, a multi-value conversion means which takes the aforementioned first input correction level as an input, compares it with threshold levels in multiple dither matrixes in order to output multi-value conversion data, and selects and outputs a multi-value conversion level corresponding to the multi-value conversion data, a second input correction means which adds the input level of the aforementioned target pixel to the aforementioned accumulated error in order to output a second correction level, a difference computation means which obtains the multi-value conversion error as the difference between the aforementioned second input correction level and the multi-value conversion level, and an error distribution update means which computes an error distribution value corresponding to non-processed pixels around the target pixel based on the multi-value conversion error from the aforementioned difference computation means and an error distribution coefficient, adds the aforementioned error distribution value to the accumulated error at the corresponding pixel position in the aforementioned error storage means, and stores it again.

2. The image signal processor described under Claim 1 in which the correcting error computation means multiplies the accumulated error corresponding to the target pixel and the total of surrounding errors by a coefficient $1/2^n$ or $1 - (1/2^n)$ (n is a positive integer), respectively, and adds them in order to obtain an error correction level.

3. The image signal processor described under Claim 1 in which an N x N dither matrix in which n x n stationary threshold levels of a multi-value conversion error diffusion method and other n x n dither thresholds which utilize the stationary threshold levels of the aforementioned multi-value conversion error diffusion method as center threshold levels are arranged is used for the dither matrix threshold levels.

<u>Detailed explanation of the invention</u>

Industrial application field

The present invention pertains to an image signal processor equipped with a multi-value regeneration function by which image information containing a half-tone image can be regenerated using multiple values on a recording system and a display system capable of expressing the density using several levels of tones. /2

Prior art

Due to the rapid mechanization of office processing and the wide-spread use of image communications of recent years, demands for the regeneration of high-quality images, such as half-tone images and printing images, in addition to conventional binary documents in black and

white are increasing. In particular, because pseudo-half-toning of a half-tone image using a binary image conforms well with display devices and recording devices, many proposals have been made.

A dither method is well known as a means for such pseudo-half-toning. With said method, tones are regenerated according to the number of dots to be regenerated within a prescribed fixed area, wherein binary processing is carried out while comparing thresholds prepared as a dither matrix with image information input with respect to each pixel. In said method, the half-tone characteristic and resolution characteristic are directly dependent on the size of the dither matrix, and they are incompatible with each other. In addition, when used for a printing image, occurrence of a moiré pattern in the regenerated image is inevitable.

As a method which allows the aforementioned half-tone characteristic and the resolution to be compatible while demonstrating a great moiré pattern restraining effect, an error diffusion method (Literature: (R. Floyd and L. Steinberg. "An Adaptive Algorithm for Spatial Gray Scale," SID 75 Digest, pp. 36-37) is suggested.

Figure 7 is a block diagram showing the critical part for realizing the aforementioned error diffusion method. When the coordinates of a target pixel in an original image are denoted as (x,y), 701 is an error storage means, 702 is a non-processed pixel area around the target pixel indicated by an error distribution coefficient matrix, 703 is the position where accumulated error S_{xy}* at coordinates (x,y) is stored, 704 is an input terminal with the input level of I_{xy} at coordinates (x,y), 705 is an input correction means for I'_{xy} (= I_{xy} +S_{xy}), 706 is an output terminal for binary level P_{xy} with the output level of 0 or R, 707 is a signal terminal for applying fixed threshold R/2, 708 is a binary conversion means which compares input signal I_{xy} with fixed threshold R/2 and outputs P_{xy} = R when $I_{xy} \geq R/2$ or $P_{xy} = 0$ otherwise, and 709 is a difference computation means for obtaining a binary error with respect to the target pixel E_{xy} (= $I'_{xy} - P_{xy}$).

Now, accumulated error S_{xy} of the target pixel can be expressed by Equations (1) and (2).

$$S_{xy} = \Sigma K_{ij} \cdot E_{x-j+1,\ y-i+1} \qquad \cdots\cdots (1)$$

(Here, i and j indicate coordinates in the error distribution coefficient matrix.)
Said error distribution coefficient K_{ij} indicates distribution weighting to the pixels with error E_{xy} around the target pixel. In the aforementioned literature, it exemplifies

$$K_{ij} = \begin{bmatrix} & * & 7/16 \\ 3/16 & 5/16 & 1/16 \end{bmatrix} \qquad \cdots\cdots (2)$$

(here, * indicates the position of the target pixel)

In the configuration shown in Figure 7, the aforementioned computation is realized by means of error distribution computation means 710 which multiplies binary error E_{xy} with respect to the target pixel by distribution coefficients corresponding to each of the non-processed pixels A

* [Due to the nature of the original, best guesses have been made for subscripts.]

through D in surrounding non-processed pixel area 702, adds the result to the value in error storage means 701, and stores it back in the applicable position. Accumulated error at pixel position B in error storage means 701 is cleared in advance.

Furthermore, when applying the present system to a recording system or a display system with several half-tone levels, a multi-value conversion error diffusion method (for example, Japanese Patent Application No. Sho 62[1987]-235121) in which multiple levels are output using multiple fixed thresholds is adopted.

Problems to be solved by the invention

Now, as already described above, the aforementioned error diffusion method is superior to the systematic dither method in terms of the half-tone characteristic and the resolution characteristic, and it is also characteristic in that it demonstrates an outstanding moiré pattern restraining effect. However, unique patterns and textures are created due to the structure of the error area and the weighting coefficients. In particular, a unique dot pattern created by the hysteresis of an error in a highlighted area or a data area creates a sense of incongruity visually and serves as a factor for degrading the image quality. In addition, if the structure of the error area is up-sized in order to reduce errors as much as possible overall so as to realize a smooth /3
half-tone characteristic, the resolution is degraded. This kind of structure has problems in that it requires many computations, and that the processing speed is also slowed down.

[In order to solve] the problems of the aforementioned error diffusion method, in the present invention, the accumulated error at the target pixel position and surrounding errors are added so as to provide an error area which serve the role of a substantially large area while using a small error area in order to improve the half-tone characteristic, and a new error is computed from the target pixel and the accumulated error in order to achieve an equivalent density.

Furthermore, as for the system for recording or displaying using several levels of half-tones, an image signal processor which utilizes an N x N dither matrix with multiple thresholds in which n x n stationary threshold levels of the multi-value conversion error diffusion method and other n x n dither thresholds which utilize the stationary threshold levels of the aforementioned multi-value conversion error diffusion method as center threshold levels are arranged is presented, whereby the periodicity of the dither elements can be merged with the random trait of the error diffusion method so as to improve the texture in highlighted and dark areas, and the generation of a moiré pattern during the regeneration of an image with loopholes can be restrained relatively well so as to obtain a high-quality regenerative image.

Means to solve the problems

The present invention is an image signal processor used for a multi-value conversion of the levels of a multi-tone image signal sampled by the unit of a pixel, which processor is equipped with

an error storage means which stores a multi-value conversion error of a target pixel in correspondence with the pixel positions around it,

a correcting error computation means which adds an accumulated error corresponding to the position of the target pixel in the aforementioned error storage means to surrounding errors in order to output an error correction level,

a first input correction means which adds the aforementioned error correction level to the input level of the aforementioned target pixel in order to output a first input correction level,

a multi-value conversion means which compares the first input correction level with threshold levels in multiple dither matrixes in order to determine a multi-value conversion level of the target pixel,

a second input correction means which adds the input level of the aforementioned target pixel to the aforementioned accumulated error in order to output a second correction level,

a difference computation means which obtains a multi-value conversion error based on the difference between the aforementioned second input correction level and the multi-value conversion level, and

an error distribution update means which computes an error distribution value corresponding to non-processed pixels around the target pixel from the multi-value conversion error from the aforementioned difference computation means [and an error distribution coefficient], adds the aforementioned error distribution value with the accumulated error at the corresponding pixel position in the aforementioned error storage means, and stores it again; wherein in particular, the correcting error computation means multiplies the accumulated error corresponding to the target pixel and the total of surrounding errors by a coefficient $1/2^n$ or $1 - (1/2^n)$, respectively (n is a positive integer), and adds them in order to obtain an error correction level, and the multiple dither matrixes are configured using an N x N dither matrix in which n x n stationary threshold levels of a multi-value conversion error diffusion method and other n x n dither thresholds which utilize the stationary threshold levels of the aforementioned multi-value conversion error diffusion method as center threshold levels are arranged in order to achieve the aforementioned goal.

Operation

The present invention has the aforementioned configuration, whereby the input correction level, which takes the accumulated error corresponding to the position of the target pixel and

surrounding accumulated errors into consideration also, is converted into multiple values, and a new multi-value conversion error is obtained based on the difference between the sum of the target pixel and the accumulated error and the multi-value conversion output in order to improve the half-tone characteristic; combinations of error diffusion method threshold levels and dither threshold levels are arranged for the thresholds in the dither matrixes in order to realize a high-quality regenerative image; and the error distribution coefficient is set at $1/2^n$ in order to realize high-speed processing.

In addition, it is configured such that an appropriate computation coefficient is selected by the aforementioned correcting error computation means in order to control the image quality.

Application example

Figure 1 is a block diagram showing the critical part of an image signal processor in an application example of the present invention.

In Figure 1, when the coordinates of the target pixel in the original image are denoted as (x,y), 1 is an error storage means, 2 is a non-processed area around the target pixel indicated by an error distribution coefficient matrix, 3 is the position where accumulated error S_{xy} at coordinates (x,y) is stored, 4 is an input terminal with the input level of I_{xy} at coordinates (x,y), 5 is a first input correction means which takes input level I_{xy} and correcting error level e_{xy} as the output of correcting error computation means 12 as inputs so as to output a first input correction level I_{1xy}, 6 is an output terminal for multi-value conversion signal P_{nxy}, 7 is a multi-value conversion means which compares the first input correction level with multiple thresholds to output multi-value signal P_n (x,y) and selects the multi-value conversion level corresponding /4
to the multi-value converted output signal so as to output it to difference computation means 8, 101 is a second input correction means which takes input level I_{xy} of the original image and accumulated error S_{xy} as inputs so as to output a second input correction level, 8 is a difference computation means which outputs multi-value conversion error E_n (x,y) as the difference between the aforementioned second input correction level and the multi-value conversion level, 10 is an error distribution update means which stores newly accumulated errors obtained by adding the results of the computation of error distribution coefficients corresponding to non-processed pixels around the target pixel and multi-value conversion error to the errors of surrounding pixel area 2 accumulated thus far back into pixel positions A through D in error storage means 1, 11 is a correcting error computation means which takes accumulated error S_{xy} corresponding to target pixel position 3 and accumulated errors within the surrounding non-processed pixel areas as inputs so as to output error correction level e_{xy}.

Operation of the aforementioned configuration will be explained in detail below using a 4-value conversion output as an example.

For the first input correction level output from first input correction means 5, the result of the multiplication of accumulated error S_{xy} corresponding to the target pixel position by coefficient K_a and the result obtained by adding accumulated errors S_A, S_B, S_C, and S_D corresponding to areas A, B, C, and D around target pixel position 3 and multiplying this result by coefficient K_b are added by correcting error computation means 12 in order to output correcting error level e_{xy}. Aforementioned correcting error level e_{xy} and input level I_{xy} are added by first input correction means 5 in order to output the first input correction level.

Next, the multi-value conversion means and the difference computation means will be explained using Figure 2. First input correction level I_{1xy} as the output of first input correction means 5 is input to comparators 201, 202, and 203, respectively; and it is compared with preset threshold T_1 of dither matrix 205, threshold T_2 of dither matrix 206, and threshold T_3 of preset dither matrix 207 in order to output multi-value converted signals A, B, and C.

The multi-value converted signals A, B, and C are output as A = B = C = "0"when the first input correction level is lower than threshold T_1, as A= "1" and B = C = "0"when it is equal to threshold T_1 or lower than threshold T_2, as A = B = "1" and C = "0" when it is equal to threshold T_2 or lower than threshold T_3, and as A = B = C = 1 when it is higher than threshold T_3.

The aforementioned multi-value converted output signals are modulated using a 4-value amplitude modulation signal or pulse width modulation signal by modulator 205 shown in Figure 2(b) and input to storage system 206. Now, upon receiving the aforementioned multi-value converted signals, selector 204 selects prescribed multi-value converted output level R_n according to the aforementioned multi-value converted output signals and outputs it. For example, it outputs multi-value converted output level $R_0 = 0$ when multi-value converted signals A, B, and C are all "0"; $R_1 = 85$ when they are "1," "0," and "0"; $R_2 = 170$ when they are "1," "1," and "0"; and $R_3 = 255$ when they are "1," "1," and "1."

Difference computation means 8 subtracts aforementioned multi-value converted output level R_3 from the second input correction level obtained by second input correction means 101 by adding accumulated error S_{xy} at the position corresponding to target pixel 3 with input level I_{xy} and outputs multi-value conversion error $E_3(xy) = I_{2xy} - R_3$. As for the multi-value conversion error obtained here, accumulated errors $S_{A'}$, $S_{C'}$, and $S_{D'}$ found thus far during the pixel processing which are stored in [sic; at storage positions] corresponding to the respective positions in surrounding non-processed pixel area 2 are read by error distribution update means 11 in order to compute new accumulated errors S_A, S_B, S_C, and S_D. Then, update processing is carried out in order to store the new accumulated errors to storage devices corresponding to pixel positions A through D in error distribution storage means 1.

When the first input correction level is denoted as I_{1xy}, the second input correction level as I_{2xy}, and multi-value level of image signal as R_n, the aforementioned steps for processing 1 pixel can be expressed by the following equations.

$$\begin{aligned} I_{1xy} &= I_{xy} + e_{xy} \\ &= I_{xy} + K_a \cdot S_{xy} + K_b \,(S_A + S_C + S_D) \cdots (4) \end{aligned}$$

(Here, $0 < K_a < 1$, $0 < K_b < 1$)

$$I_{2xy} \geq T_n \cdots\cdots\cdots P_{xy} = R_n$$

$$I_{2xy} < T_n \cdots\cdots\cdots P_{xy} = R_{n-1}$$

$$\left\{\begin{aligned} T_n &= (R_{n-1} + R_n)/2 \\ E_{xy} &= I_{2xy} - P_{xy} \\ &= (I_{1xy} + S_{xy}) - P_{xy} \end{aligned}\right. \qquad \cdots\cdots (5)$$

$$\left\{\begin{aligned} S_A &= S_A' + K_A E_{xy} \\ S_B &= K_B E_{xy} \\ S_C &= S_C + K_C E_{xy} \end{aligned}\right.$$

/5

$$S_D = S_D' + K_D E_{xy} \qquad \cdots\cdots (6)$$

Next, input I_{1xy} and multi-value conversion error E_{xy} will be explained in detail.

Now, assuming that error distribution coefficients K_A through K_D corresponding to the respective positions in the surrounding pixel area are 1, and coefficients $K_a = K_b = 1$, as shown in Figure 3, because each sum of the errors accumulated during the process thus far can be expressed as

$$\left\{\begin{aligned} S_{xy} &= 1/4\,(E_{x-1,y-1} + E_{x,y-1} + E_{x+1,y-1} \\ &\qquad + E_{x-1,y}) \\ S_A' &= 1/4\,(E_{x,y-1} + E_{x+1,y-1} + E_{x+2,y-1}) \\ S_B' &= 0 \\ S_C' &= 1/4\,(E_{x-1,y}) \\ S_D' &= 1/4\,(E_{x-2,y} + E_{x-1,y}) \end{aligned}\right.$$

,

correcting error level e_{xy} for correcting to input level I_{xy} becomes the value obtained by addition in

$$\begin{aligned} e_{xy} &= S_{xy} + (S_A' + S_C' + S_D') \\ &= 1/4\,(E_{x-1,y-1} + 2E_{x,y-1} + 2E_{x+1,y-1} \\ &\qquad + 3E_{x-1,y} + E_{x+2,y-1} + E_{x-2,y}) \end{aligned} \qquad \cdots\cdots (7)$$

will result. Therefore, a surrounding area around the target pixel, that is, an error filter structure, of the kind shown in Figure 4 is formed in terms of the correlation between the target pixel and the accumulated error. To correct input correction level I_{xy} the error filter formed based on said correlation means is used to correct the surrounding error elements including the target pixel, so that a regenerative image with a fine texture can be obtained.

Next, a new multi-value conversion error as one of the characteristics of the present invention is obtained by subtracting the result of binary conversion of aforementioned input correction level I_{1xy} from second input correction level I_{2xy} obtained by adding accumulated error S_{xy} to input level I_{xy}. The reason is that error level e_{xy} to be corrected to input level I_{xy} in the present invention is obtained by weighting a portion of the error elements generated from the correlation between the target pixel and the errors around it, but it does not satisfy the density conservation system. Thus, new error E_{xy} for maintaining the density conservation system is obtained from accumulated errors in a system in which the total sum of the target pixel and the error distribution coefficients becomes 1, that is, the value obtained by adding $S_{xy} = \sum K_{ij} \cdot E_{x-i+1,\, y-j+1}$ and input level I_{xy}.

Although coefficient K_a used to multiply accumulated error S_{xy} and coefficient K_b used to multiply the total sum of accumulated errors S_A, S_B, and S_D in the surrounding pixel area were set as $K_a = K_b = 1$ when computing error correction level e_{xy} for the sake of convenience, when K_a and K_b are reduced into the ranges of $0 < K_a < 1$, and $0 < K_b < 1$, an output image with emphasized dither elements can be obtained.

When these coefficients are set at $1/2^n$ (n is an integer) or $1 - 1/2^n$, the logical operation become easier, and high-speed processing can be realized.

Next, dither matrix thresholds in the present application example will be explained in detail.

Figure 5(a) is a 90° dither pattern applied to the present application example, (b) of said figure is a 45° dither pattern, (c) of said figure is a pattern obtained when (a) of said figure is unfolded, and (d) through (f) of said figure are basic 4-value dither pattern examples of (a) of said figure. In addition, (g) of said figure is a helical dither pattern commonly utilized.

Now, dot patterns created based on combinations of dither pattern thresholds and their arrangements will be described. When the pattern in (g) of said figure is adopted for the dither matrix thresholds of the present device, the dot pattern produces an image with emphasized dither elements. In addition, because the matrix is small, the half-tone levels expressed by the dither are low; and because [the gap] between the levels is corrected by an error, the image quality is poor. Because this kind of pattern has quite strong dither elements, a moiré pattern is observed clearly during the regeneration of an image with loopholes. When the dither matrix is up-sized, the resolution is degraded. (a) of said figure is to solve said problems.

The parts with slanted lines in Figure 5(a) are arranged using a fixed threshold processed in the error diffusion method while determing threshold levels 1 through 8 in such a manner that said threshold becomes the center threshold of a 4 x 4 matrix. With this arrangement, a periodic pattern structure comprising 2 x 2 dithers and 2 x 2 thresholds of the error diffusion method is realized as shown in the unfolded view in (c) of said figure. Therefore, the threshold area of the error diffusion method has a random dot pattern structure. Because propagation errors occurring in said area of the error diffusion method are absorbed by the highly periodic dither pattern, /6
creation of a stripe pattern unique to the error diffusion method is unlikely. The regenerative image becomes an image in which periodic dots and random dots are well fused. This kind of dot pattern has an effect of restraining a moiré pattern during the regeneration of an image with loopholes. The levels of thresholds D_1, D_2, and D_3 in the case of the 4-value conversion system in (d) of said figure are set according to the fixed threshold level of the multi-value conversion error diffusion method. That is, when the output levels are $R_0 = 0$, $R_1 = 85$, $R_2 = 170$, and $R_3 = 255$, $D_1 = (0 + 85)/2 = 43$, $D_2 = (85 + 170)/2 = 128$, and $D_3 = (170 + 255)/2 = 213$. Figure 6, in which thresholds are arranged in such a manner that these threshold levels are used as center thresholds of respective matrixes, shows actual 4-value dither patterns obtained when the thresholds are arranged in accordance with the distribution order in Figure 5.

Effect of the invention

As described above, in the present invention, because the input correction level obtained by adding a part of the accumulated error corresponding to the target pixel position and a part of the total sum of the surrounding accumulated errors to the target pixel and correcting [the result] is compared with multiple dither matrix thresholds and converted into multiple values, a new multi-value conversion error is obtained by subtracting the multi-value conversion levels corresponding to the aforementioned multi-value converted signals from the correction level obtained by adding the target pixel and the accumulated error at the target pixel position, and the multiple dither matrix thresholds are arranged in combination with other dither thresholds around the threshold level of the multi-value conversion error diffusion method, the texture in the highlighted and dark areas can be improved, and the occurrence of a moiré pattern can be restrained. As a result, a regenerative image with a smooth half-tone characteristic can be achieved. In addition, the image quality can be controlled by selecting coefficients K_a and K_b of correcting error level e_{xy} appropriately; and when the coefficients are set at $1/2^n$ or $1 - 1/2^n$, the computation can be realized at high speed.

A fine smooth binary regenerative image with high resolution can be obtained without an incidence of texture and without a unique stripe pattern created during conventional error

diffusion also when error distribution coefficients (weighting coefficients) are determined uniformly.

Brief description of the figures

Figure 1 is a block diagram showing the wiring of an image signal processor in an application example of the present invention. Figures 2(a) and (b) are block diagrams showing the wiring at the critical parts of said device. Figure 3 is a schematic diagram of the surrounding error area created by the correcting error computation means of said [device]. Figure 4 shows schematic diagrams of the error filter structure in the correlation between the target pixel and the accumulated error in said device. Figure 5 shows diagrams of dither patterns in said device. Figure 6 shows diagrams of 4-value dither patterns with actual arrangements of thresholds. Figure 7 is a block diagram showing the wiring of a device used to realize the conventional error diffusion method.

1 … error storage means; 2 … surrounding pixel area; 3 … target pixel position; 4 … input terminal; 5 … first input correction means; 6 … multi-value converted signal output terminal; 7 … multi-value conversion means; 8 … difference computation means; 101 … second input correction means; 11 …error distribution update means; 12 … correcting error computation means; 201, 202, 203 … comparator; 204 … selector; 205 … modulator; and 206 … storage system.

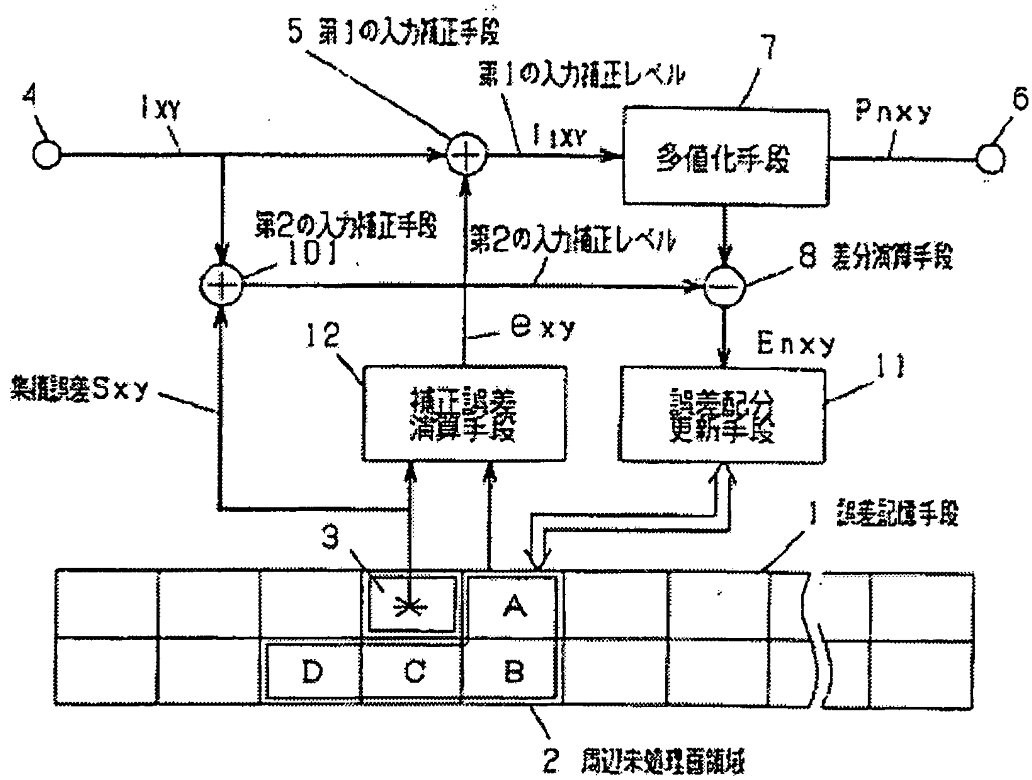


Figure 1

Key:

Key:	a	First input correction level
	b	Second input correction level
	c	Accumulated error
	1	Error storage means
	2	Surrounding non-processed pixel area
	5	First input correction means
	7	Multi-value conversion means
	8	Difference computation means
	11	Error distribution update means
	12	Correcting error computation means
	101	Second input correction means

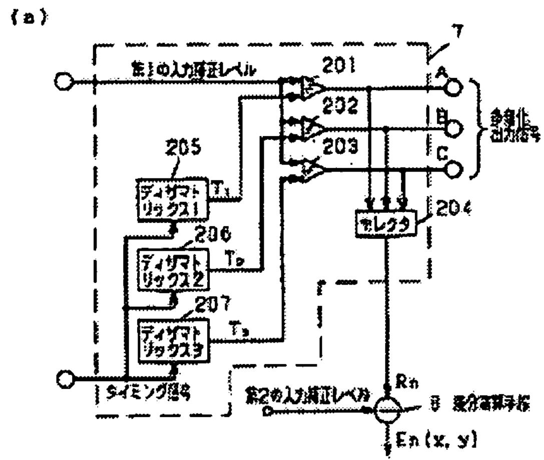


Figure 2(a)

Key: a First input correction level
b Timing signal
c Multi-value converted output signal
d Second input correction level
8 Difference computation means
204 Selector
205-207 Dither matrix

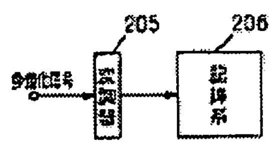


Figure 2(b)

Key: a Multi-value converted signal
205 Modulator
206 Storage system

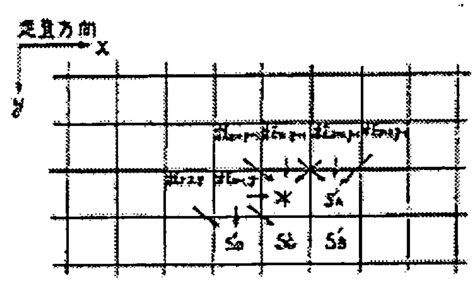


Figure 3

Key: 1 Scanning direction

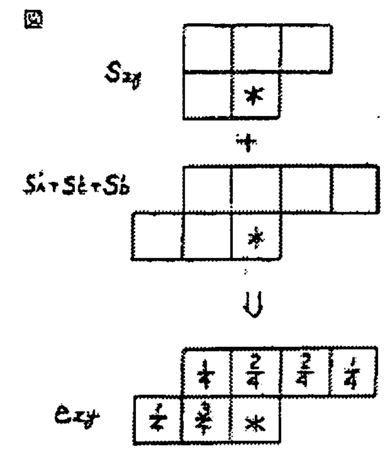


Figure 4

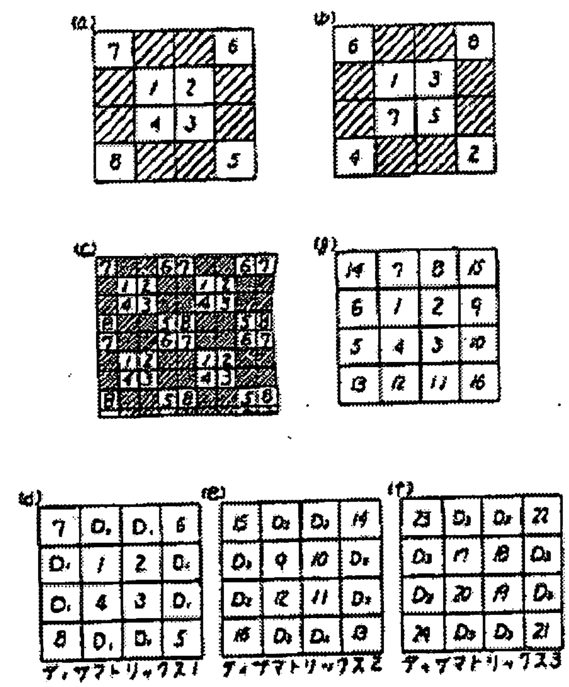


Figure 5

Key: 1 Dither matrix ___

Figure 6

Key: 1 Dither matrix threshold ___

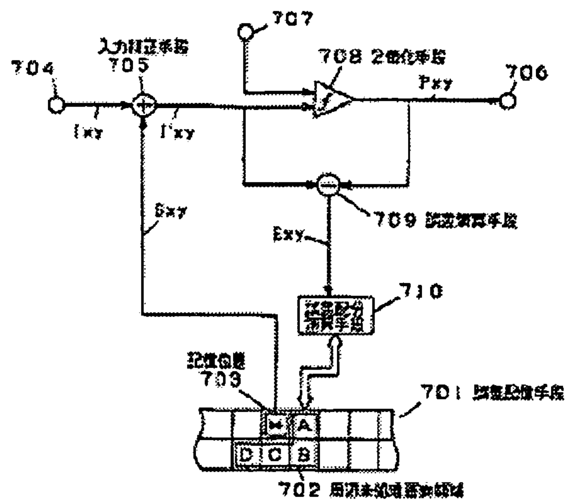


Figure 7

Key:

701	Error storage means
702	Surrounding non-processed pixel area
703	Storage position
705	Input correction means
708	Binary conversion means
709	Difference computation means
710	Error distribution computation means